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FINAL IAGS TECHNICAL TEAM MEMORANDUM 99-3
BRICK LINED PIT SOIL RESULTS

FOR THE
CAMP EDWARDS IMPACT AREA
GROUNDWATER QUALITY STUDY

MASSACHUSETTS MILITARY RESERVATION
CAPE COD, MASSACHUSETTS

Prepared for

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1. Introduction

1.1 Purpose of Investigation

The purpose of the soil sampling at the Brick-lined pits was to evaluate whether historic disposal of munitions or other debris had contributed to soil contamination.

1.2 Organization of Technical Memorandum

Section 2, Background includes a discussion of the site location, any prior investigations, and any additional work being conducted or proposed for the area of interest. Section 3, Procedures, discusses the sampling and an analytical method used and Section 4, Results, includes the results for the soil samples. Section 5, Evaluation, includes a discussion of contaminant distribution, contaminant fate-and-transport, and a preliminary risk evaluation. The remaining sections include Section 6, Conclusions, Section 7, Recommendations, and Section 8, References.

2. Background

2.1 Location on MMR

The brick-lined pits are located along the J-2 Range, between Barlow Road and Greenway Road on the southeast side of the Impact Area (Figure 1). The J-2 Range was reportedly used as a DOD contractor test range between about 1970 and the late 1980's (USACE, 1999). Activities on this range included testing propellants and fuzes in 81mm mortars, testing fins on 60mm mortars, testing 66mm LAW HEAT rounds, developing 35mm LAWsubcaliber rounds, and operating an OCTOL melt-pour facility.

The two oval pits have brick walls and measure several feet across, located along the southern edge and near the end of what was once a cleared area for the J-2 Range (Figure 2). Prior to excavation the pits appeared to be partially filled with soil and debris (Photographs A and B). According to personnel who have worked on the J-2 Range, the pits were likely used to house electronics or for spotting bunkers. The Guard proposed to excavate these two locations in the Phase IIa. Workplan (Ogden, 1998a).

2.2 Prior Investigations

There has been no prior sampling at either of the Brick-lined pit locations.

2.3 Context

No other investigations have been proposed for the Brick-lined pit locations. However, these locations are part of the J-2 Range which remains to be investigated uder the IAGS. The Guard has proposed in the Phase IIa Workplan to develop a separate investigation plan for the J Ranges based on information from the USACE Archives Search Report (Ogden, 1998a). Additional information for this plan is currently being requested from one of the DOD contractors that operated the J-3 Range, and conducted work on the J-1 Range.

3. Procedures

The excavation were begun and completed in February 1999. Trained UXO personnel excavated each pit to the bottom of the brick wall, approximately 8 ft deep. Soil and munitions debris from each pit were contained on and under plastic to prevent precipitation runoff. The location of the brick-lined pits is designated as Area 47 for the purpose of the IAGS.

Two composite samples were collected from each excavation, one from the sidewalls (locations 47A in Pit #1 and 47C in Pit #2) and one from the bottom (locations 47B in Pit #1 and 47D in Pit #2). The sidewall composite from each excavation included at least four samples, one from the center of each side (Figure 3). The bottom composite included four samples spaced evenly around the perimeter of the brick structure at its bottom edge. A composite sample was collected of the soil removed from each excavation (locations 47E in Pit #1 and 47F in Pit #2), by compositing several representative locations within the resulting soil pile.

The soil samples were collected using a hand auger and then composited in a stainless steel bowl in accordance with ASTM 1996. A portion of the soil sample from each sample point in the composite group was placed in an individual jar or plastic bag for headspace analysis using a photo ionization detector (PID). A volatile organic compound (VOC) grab sample was collected from one sample point within each composite group using the following priority of characteristics;

- Highest response on the PID, or
- Visual signs of contamination, or
- Random selection

The grab samples were analyzed for VOCs using Method OLM03.1, and for EDB and MTBE using Method 8021. The composite samples were submitted for the following analytes:

Analyte	Method
SVOC	OLM03.1
Pesticide/PCB	OLM03.1
Herbicide	8151
Metals	6010
Cyanide	ILM04
Phosphate-Phosphorous	365.2
Nitrate/Nitrite-Nitrogen	353.2
Ammonia-Nitrogen	350.2
Total Organic Carbon`	Lloyd Kahn
Explosive	8330

4. Results

The brick-lined pits contained a variety of small caliber munitions and spent (inert) casings. No High Explosive (HE) rounds were identified in either pit. Munitions excavated from Pit #1 included 1000 pounds of various scrap munitions including 0.50 cal, 7.62mm, 0.30 cal, M1 clips, M20 smoke grenade canisters, and LAW rocket motors (Photographs A and B). Munitions excavated from Pit #2 included a 40mm flare cartridge (empty), two 3.5-inch rocket motors (expended), and one 3.5-inch rocket practice head (Photographs C and D).

Soil sampling results are presented in Appendix A and a statistical summary of these results is provided in Table 1. Detections are summarized in Figure 4 for all analytes except metals, and in Figure 5 for metals. The metals detections illustrated in Figure 4 are only those compounds with concentrations that exceeded the background concentrations proposed in the Draft Completion of Work Report (Ogden, 1998a). The following depths are indicated for the composite samples: 0 feet for the excavated soil, 4 feet for the excavation sidewalls, and 8 feet for the excavation bottom.

The sample data indicate no explosive compounds are present in any of the six composite samples collected. A single detect of bis (2-ethylhexyl) phthalate (BEHP), a semi-volatile organic compound (SVOC), was observed in sample B47AAA at a concentration of 2,600 ug/kg. This sample came from the sidewall of Pit #1. The only volatile organic compound (VOC) detected was acetone, which was present in 5 samples. Acetone concentrations varied from 5 to 14 ug/kg. No pesticides, PCBs, or herbicides were detected in the soil samples.

Metal analytes were detected primarily in the excavated soil, as indicated in Figure 5. Metal and inorganic compounds in the excavated soil that exceeded proposed background levels included calcium, copper, lead, magnesium, manganese, molybdenum,

Table 1. Summary of soil results for the Brick-Lined Pits

Method	Analyte	Units	Number of Samples	Number of Rejects	Number of Detects	Sample ID With Maximum Value	Maximum Value	Flag	Mean of Detects	Standard Deviation of Detects
350.2M	Nitrogen, Ammonia (As N)	mg/kg	6	0	2	B47FAA	8.95		5.07	5.5
353.2M	Nitrate/Nitrite (As N)	mg/kg	6	0	5	B47FAA	0.06		0.03	0
365.2	Total Orthophosphate	mg/kg	6	0	6	B47CAA	135		107.05	28.5
8021S	1,2-Dibromoethane (EDB)	ug/kg	6	0	0	No Detects				
8021S	MTBE	ug/kg	6	0	0	No Detects				
8151	Dalapon	ug/kg	7	1	0	No Detects				
8151	3,5-Dichlorobenzoic Acid	ug/kg	7	1	0	No Detects				
8151	4-Nitrophenol	ug/kg	7	1	0	No Detects				
8151	Dicamba	ug/kg	7	1	0	No Detects				
8151	MCPP	ug/kg	7	1	0	No Detects				
8151	MCPA	ug/kg	7	1	0	No Detects				
8151	Dichloropropylene	ug/kg	7	1	0	No Detects				
8151	2,4-	ug/kg	7	1	0	No Detects				
8151	Pentachlorophenol	ug/kg	7	1	0	No Detects				
8151	Silvex (2,4,5-Tp)	ug/kg	7	1	0	No Detects				
8151	Chloramben	ug/kg	7	3	0	No Detects				
8151	2,4,5-T	ug/kg	7	1	0	No Detects				
8151	2,4 DB	ug/kg	7	1	0	No Detects				
8151	Picloram	ug/kg	7	1	0	No Detects				
8151	Bentazon	ug/kg	7	1	0	No Detects				
8151	Dinoseb	ug/kg	7	1	0	No Detects				
8151	DCPA (Dacthal)	ug/kg	7	1	0	No Detects				
8151	Acifluorfen	ug/kg	7	5	0	No Detects				
8330N	RDX	ug/kg	6	0	0	No Detects				
8330N	HMX	ug/kg	6	0	0	No Detects				
8330N	1,3,5-Trinitrobenzene	ug/kg	6	0	0	No Detects				
8330N	1,3-Dinitrobenzene	ug/kg	6	0	0	No Detects				
8330N	Tetryl	ug/kg	6	0	0	No Detects				
8330N	Nitrobenzene	ug/kg	6	0	0	No Detects				
8330N	2,4,6-Trinitrotoluene	ug/kg	6	0	0	No Detects				
8330N	4-Amino-2,6-Dinitrotoluene	ug/kg	6	0	0	No Detects				
8330N	2-Amino-4,6-Dinitrotoluene	ug/kg	6	0	0	No Detects				
8330N	2,6-Dinitrotoluene	ug/kg	6	0	0	No Detects				
8330N	2,4-Dinitrotoluene	ug/kg	6	0	0	No Detects				
8330N	Picric Acid	ug/kg	6	0	0	No Detects				
8330N	2-Nitrotoluene	ug/kg	6	0	0	No Detects				
8330N	4-Nitrotoluene	ug/kg	6	0	0	No Detects				
8330N	3-Nitrotoluene	ug/kg	6	0	0	No Detects				
8330N	2,6-Diamino-4-Nitrotoluene	ug/kg	6	0	0	No Detects				
8330N	2,4-Diamino-6-Nitrotoluene	ug/kg	6	0	0	No Detects				
8330N	Pentaerythritol Tetranitrate	ug/kg	6	0	0	No Detects				
8330N	Nitroglycerin	ug/kg	6	0	0	No Detects				

Method	Analyte	Units	Number of Samples	Number of Rejects	Number of Detects	Sample ID With Maximum Value	Maximum Value	Flag	Mean of Detects	Standard Deviation of Detect
9038	Sulfate (As So4)	mg/kg	6	0	4	B47BAA	96		32.17	42.7
9250	Chloride (As Cl)	mg/kg	6	0	6	B47BAA	3.8		1.58	1.1
CYAN	Cyanide	mg/kg	6	0	0	No Detects				
IM40HG	Mercury	mg/kg	6	0	0	No Detects				
IM40MB	Aluminum	mg/kg	6	0	6	B47FAA	8180		4370	2352
IM40MB	Antimony	mg/kg	6	0	0	No Detects				
IM40MB	Arsenic	mg/kg	6	0	4	B47BAA	1.6	J	1.42	0.2
IM40MB	Barium	mg/kg	6	0	6	B47CAA	21.5		12.3	6.4
IM40MB	Beryllium	mg/kg	6	0	4	B47FAA	0.26		0.22	0
IM40MB	Cadmium	mg/kg	6	0	0	No Detects				
IM40MB	Calcium	mg/kg	6	0	6	B47FAA	362		215.17	90.3
IM40MB	Chromium, Total	mg/kg	6	0	6	B47FAA	9.9		6.03	3.1
IM40MB	Cobalt	mg/kg	6	0	6	B47EAA	4.1		2.92	0.8
IM40MB	Copper	mg/kg	6	0	6	B47EAA	8		5.28	1.6
IM40MB	Iron	mg/kg	6	0	6	B47FAA	10000		6085	2448
IM40MB	Lead	mg/kg	6	0	6	B47FAA	53.6		12.9	20.1
IM40MB	Magnesium	mg/kg	6	0	6	B47EAA	1680		952.17	424.2
IM40MB	Manganese	mg/kg	6	0	6	B47CAA	914		347.32	348.1
IM40MB	Nickel	mg/kg	6	0	6	B47EAA	5.9		3.98	1.3
IM40MB	Potassium	mg/kg	6	0	6	B47FAA	382		298.67	49.1
IM40MB	Selenium	mg/kg	6	0	0	No Detects				
IM40MB	Silver	mg/kg	6	0	0	No Detects				
IM40MB	Sodium	mg/kg	6	0	0	No Detects				
IM40MB	Thallium	mg/kg	6	0	4	B47CAA	1.5		1.22	0.2
IM40MB	Vanadium	mg/kg	6	0	6	B47FAA	15.3		9.32	3.5
IM40MB	Zinc	mg/kg	6	0	6	B47EAA	19.8		15.17	3.9
IM40MB	Molybdenum	mg/kg	6	0	4	B47DAA	0.71		0.5	0.2
IM40MB	Boron	mg/kg	6	0	0	No Detects				
OM31B	Phenol	ug/kg	6	0	0	No Detects				
OM31B	Bis(2-Chloroethyl) Ether	ug/kg	6	0	0	No Detects				
OM31B	2-Chlorophenol	ug/kg	6	0	0	No Detects				
OM31B	1,3-Dichlorobenzene	ug/kg	6	0	0	No Detects				
OM31B	1,4-Dichlorobenzene	ug/kg	6	0	0	No Detects				
OM31B	1,2-Dichlorobenzene	ug/kg	6	0	0	No Detects				
OM31B	2,2'-Oxybis(1-Chloro)Propane	ug/kg	6	0	0	No Detects				
OM31B	2-Methylphenol (O-Cresol)	ug/kg	6	0	0	No Detects				
OM31B	Hexachloroethane	ug/kg	6	0	0	No Detects				
OM31B	N-Nitrosodi-N-Propylamine	ug/kg	6	0	0	No Detects				
OM31B	4-Methylphenol (P-Cresol)	ug/kg	6	0	0	No Detects				
OM31B	Nitrobenzene	ug/kg	6	0	0	No Detects				
OM31B	Isophorone	ug/kg	6	0	0	No Detects				
OM31B	2-Nitrophenol	ug/kg	6	0	0	No Detects				
OM31B	2,4-Dimethylphenol	ug/kg	6	0	0	No Detects				
OM31B	Bis(2-Chloroethoxy) Methane	ug/kg	6	0	0	No Detects				

Method	Analyte	Units	Number of Samples	Number of Rejects	Number of Detects	Sample ID With Maximum Value	Maximum Value	Flag	Mean of Detects	Standard Deviation of Detects
OM31B	2,4-Dichlorophenol	ug/kg	6	0	0	No Detects				
OM31B	1,2,4-Trichlorobenzene	ug/kg	6	0	0	No Detects				
OM31B	Naphthalene	ug/kg	6	0	0	No Detects				
OM31B	4-Chloroaniline	ug/kg	6	0	0	No Detects				
OM31B	Hexachlorobutadiene	ug/kg	6	0	0	No Detects				
OM31B	4-Chloro-3-Methylphenol	ug/kg	6	0	0	No Detects				
OM31B	2-Methylnaphthalene	ug/kg	6	0	0	No Detects				
OM31B	Hexachlorocyclopentadiene	ug/kg	6	0	0	No Detects				
OM31B	2,4,6-Trichlorophenol	ug/kg	6	0	0	No Detects				
OM31B	2,4,5-Trichlorophenol	ug/kg	6	0	0	No Detects				
OM31B	2-Chloronaphthalene	ug/kg	6	0	0	No Detects				
OM31B	2-Nitroaniline	ug/kg	6	0	0	No Detects				
OM31B	Dimethyl Phthalate	ug/kg	6	0	0	No Detects				
OM31B	Acenaphthylene	ug/kg	6	0	0	No Detects				
OM31B	2,6-Dinitrotoluene	ug/kg	6	0	0	No Detects				
OM31B	Acenaphthene	ug/kg	6	0	0	No Detects				
OM31B	3-Nitroaniline	ug/kg	6	0	0	No Detects				
OM31B	2,4-Dinitrophenol	ug/kg	6	0	0	No Detects				
OM31B	Dibenzofuran	ug/kg	6	0	0	No Detects				
OM31B	4-Nitrophenol	ug/kg	6	0	0	No Detects				
OM31B	2,4-Dinitrotoluene	ug/kg	6	0	0	No Detects				
OM31B	Fluorene	ug/kg	6	0	0	No Detects				
OM31B	Diethyl Phthalate	ug/kg	6	0	0	No Detects				
OM31B	4-Chlorophenyl Phenyl Ether	ug/kg	6	0	0	No Detects				
OM31B	4-Nitroaniline	ug/kg	6	0	0	No Detects				
OM31B	4,6-Dinitro-2-Methylphenol	ug/kg	6	0	0	No Detects				
OM31B	N-Nitrosodiphenylamine	ug/kg	6	0	0	No Detects				
OM31B	4-Bromophenyl Phenyl Ether	ug/kg	6	0	0	No Detects				
OM31B	Hexachlorobenzene	ug/kg	6	0	0	No Detects				
OM31B	Pentachlorophenol	ug/kg	6	0	0	No Detects				
OM31B	Phenanthrene	ug/kg	6	0	0	No Detects				
OM31B	Anthracene	ug/kg	6	0	0	No Detects				
OM31B	Carbazole	ug/kg	6	0	0	No Detects				
OM31B	Di-N-Butyl Phthalate	ug/kg	6	0	0	No Detects				
OM31B	Fluoranthene	ug/kg	6	0	0	No Detects				
OM31B	Pyrene	ug/kg	6	0	0	No Detects				
OM31B	Benzyl Butyl Phthalate	ug/kg	6	0	0	No Detects				
OM31B	Benzo(A)Anthracene	ug/kg	6	0	0	No Detects				
OM31B	3,3'-Dichlorobenzidine	ug/kg	6	0	0	No Detects				
OM31B	Chrysene	ug/kg	6	0	0	No Detects				
OM31B	BEHP	ug/kg	6	0	1	B47AAA	2600			
OM31B	Di-N-Octylphthalate	ug/kg	6	0	0	No Detects				
OM31B	Benzo(B)Fluoranthene	ug/kg	6	0	0	No Detects				
OM31B	Benzo(K)Fluoranthene	ug/kg	6	0	0	No Detects				

Method	Analyte	Units	Number of Samples	Number of Rejects	Number of Detects	Sample ID With Maximum Value	Maximum Value	Flag	Mean of Detects	Standard Deviation of Detects
OM31B	Benzo(A)Pyrene	ug/kg	6	0	0	No Detects				
OM31B	Indeno(1,2,3-C,D)Pyrene	ug/kg	6	0	0	No Detects				
OM31B	Dibenz(A,H)Anthracene	ug/kg	6	0	0	No Detects				
OM31B	Benzo(G,H,I)Perylene	ug/kg	6	0	0	No Detects				
OM31P	Alpha BHC	ug/kg	6	0	0	No Detects				
OM31P	Beta BHC	ug/kg	6	0	0	No Detects				
OM31P	Delta BHC	ug/kg	6	0	0	No Detects				
OM31P	Gamma BHC (Lindane)	ug/kg	6	0	0	No Detects				
OM31P	Heptachlor	ug/kg	6	0	0	No Detects				
OM31P	Aldrin	ug/kg	6	0	0	No Detects				
OM31P	Heptachlor Epoxide	ug/kg	6	0	0	No Detects				
OM31P	Alpha Endosulfan	ug/kg	6	0	0	No Detects				
OM31P	Dieldrin	ug/kg	6	0	0	No Detects				
OM31P	DDE	ug/kg	6	0	0	No Detects				
OM31P	Endrin	ug/kg	6	0	0	No Detects				
OM31P	Beta Endosulfan	ug/kg	6	0	0	No Detects				
OM31P	DDD	ug/kg	6	0	0	No Detects				
OM31P	Endosulfan Sulfate	ug/kg	6	0	0	No Detects				
OM31P	DDT	ug/kg	6	0	0	No Detects				
OM31P	Methoxychlor	ug/kg	6	0	0	No Detects				
OM31P	Endrin Ketone	ug/kg	6	0	0	No Detects				
OM31P	Endrin Aldehyde	ug/kg	6	0	0	No Detects				
OM31P	Alpha-Chlordane	ug/kg	6	0	0	No Detects				
OM31P	Gamma-Chlordane	ug/kg	6	0	0	No Detects				
OM31P	Toxaphene	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1016 (Arochlor 1016)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1221 (Arochlor 1221)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1232 (Arochlor 1232)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1242 (Arochlor 1242)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1248 (Arochlor 1248)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1254 (Arochlor 1254)	ug/kg	6	0	0	No Detects				
OM31P	Pcb-1260 (Arochlor 1260)	ug/kg	6	0	0	No Detects				
OM31V	Chloromethane	ug/kg	7	1	0	No Detects				
OM31V	Vinyl Chloride	ug/kg	7	1	0	No Detects				
OM31V	Bromomethane	ug/kg	7	1	0	No Detects				
OM31V	Chloroethane	ug/kg	7	1	0	No Detects				
OM31V	Acetone	ug/kg	7	1	5	B47FAA	14	J	7.8	4.1
OM31V	1,1-Dichloroethene	ug/kg	7	1	0	No Detects				
OM31V	Methylene Chloride	ug/kg	7	1	0	No Detects				
OM31V	Carbon Disulfide	ug/kg	7	1	0	No Detects				
OM31V	Total 1,2-Dichloroethene	ug/kg	7	1	0	No Detects				
OM31V	1,1-Dichloroethane	ug/kg	7	1	0	No Detects				
OM31V	Methyl Ethyl Ketone	ug/kg	7	1	0	No Detects				
OM31V	Chloroform	ug/kg	7	1	0	No Detects				

Method	Analyte	Units	Number of Samples	Number of Rejects	Number of Detects	Sample ID With Maximum Value	Maximum Value	Flag	Mean of Detects	Standard Deviation of Detects
OM31V	1,1,1-Trichloroethane	ug/kg	7	1	0	No Detects				
OM31V	Carbon Tetrachloride	ug/kg	7	1	0	No Detects				
OM31V	1,2-Dichloroethane	ug/kg	7	1	0	No Detects				
OM31V	Benzene	ug/kg	7	1	0	No Detects				
OM31V	Trichloroethylene (TCE)	ug/kg	7	1	0	No Detects				
OM31V	1,2-Dichloropropane	ug/kg	7	1	0	No Detects				
OM31V	Bromodichloromethane	ug/kg	7	1	0	No Detects				
OM31V	Methyl Isobutyl Ketone	ug/kg	7	1	0	No Detects				
OM31V	Cis-1,3-Dichloropropene	ug/kg	7	1	0	No Detects				
OM31V	Toluene	ug/kg	7	1	0	No Detects				
OM31V	Trans-1,3-Dichloropropene	ug/kg	7	1	0	No Detects				
OM31V	1,1,2-Trichloroethane	ug/kg	7	1	0	No Detects				
OM31V	2-Hexanone	ug/kg	7	1	0	No Detects				
OM31V	Tetrachloroethylene(PCE)	ug/kg	7	1	0	No Detects				
OM31V	Dibromochloromethane	ug/kg	7	1	0	No Detects				
OM31V	Chlorobenzene	ug/kg	7	1	0	No Detects				
OM31V	Ethylbenzene	ug/kg	7	1	0	No Detects				
OM31V	Xylenes, Total	ug/kg	7	1	0	No Detects				
OM31V	Styrene	ug/kg	7	1	0	No Detects				
OM31V	Bromoform	ug/kg	7	1	0	No Detects				
OM31V	1,1,2,2-Tetrachloroethane	ug/kg	7	1	0	No Detects				
TOC	Total Organic Carbon	mg/kg	6	0	5	B47FAA	3710		1188.2	1444

nitrate/nitrite, ammonia nitrogen, and thallium. Metals in the excavation sidewalls or bottom that exceeded proposed background levels included molybdenum in pit #1, and copper, manganese, molybdenum, and thallium in pit #2.

5. Evaluation

5.1 Contaminant Distribution and Transport

Acetone appears to be evenly distributed at a very low level in the soil samples. The measured concentrations of acetone were similar for the two dates of sampling; 5 ug/kg for samples collected on 2/24/99, and 10-14 ug/kg for samples collected on 3/3/99. Although these are validated results, it is possible that the measured concentrations reflect contaminant introduced through sampling or analysis, rather than contaminant actually present in the soil. Acetone was identified in many quality assurance samples during Phase I of the IAGS (Ogden, 1998a) and during the current Phase II investigation.

During the first half of the Phase IIa field program, December 1998 through June 1999, acetone was the most frequently detected compound observed in equipment rinsate blanks with detectable concentrations ranging from 3J to 5 ug/L in six of the seven samples obtained. During that same time period, there were only two soil sample duplicate pairs that exhibited detectable concentrations of acetone. One pair revealed identical concentrations of acetone at 2 ug/kg, and the other pair showed acetone only in the duplicate at a concentration of 8 ug/kg. Trip blank results for the two shipments of soil samples associated with the Brick-Lined Pit investigation revealed no detectable concentrations of VOCs. Similarly, acetone was not detected in the field blanks obtained during the first half of 1999.

These QC sample results suggest that acetone may be introduced during decontamination, and the negligible, yet consistent, concentrations detected in Brick-Lined-Pit samples and perhaps other Phase IIa soils may be attributable to cross contamination from sampling equipment. Moreover, the acetone concentrations observed in soil samples collected elsewhere during Phase IIa were similar in magnitude suggesting the same source mechanism. The absence of acetone in trip blanks and field blanks suggests acetone is not likely introduced to the samples during shipment or laboratory analysis.

BEHP was detected in the composite from the sidewalls of pit #1. BEHP was not detected in the soil removed from this pit. BEHP is a typical cross-contaminant from sampling handling and laboratory analysis, and was also identified in many quality assurance samples during Phase I and Phase IIa of the IAGS (Ogden, 1998a).

The concentrations of metals in these soil samples suggest that metal and inorganic compounds are present at higher levels within the materials in the pit than in the surrounding soils. Fewer metals were detected above proposed background levels in the excavation sidewalls and bottoms, as indicated in Figure 5. However, since only a few soil samples were collected, it is possible that the apparent difference may not be statistically significant. If the concentrations are actually higher in the pits than in the surrounding soils, possible explanations would include the following: (1) the metallic debris in the pits has leached into the soil contained in the pits, but not into the soil surrounding the pits; (2) the soil samples from the pits included metal fragments or oxides from the comingled metallic debris.

5.2 Preliminary Risk Evaluation

Currently there are no risk-based criteria for soils under the Impact Area Groundwater Study. Such criteria are typically calculated on a site-specific basis considering the opportunity for direct exposure of humans to the soils, and the opportunity for indirect exposure through leaching to groundwater. Such calculations would require use of a groundwater model and/or experimental determination of the soil concentration that would pose a threat to groundwater.

The Massachusetts Contingency Plan (MCP) lists several criteria that may be considered for the contaminants of interest (Table 2):

- MCP S1 Reportable Concentrations (RCS1) establish the threshold concentrations above which notification to the MADEP of a release of hazardous materials is required. The RCS1 Reportable Concentrations are applicable for soil existing above a drinking water resource and take into account direct contact with impacted soil. The RCS1 criteria are not clean-up standards; however, they do establish an important regulatory threshold and they provide a frame of reference for compounds which may be detected during the soil sampling.
- MCP Method 1 S-1/GW-1 cleanup standards are conservative standards that take into consideration direct contact and leaching to groundwater used as a drinking water source.

The maximum concentrations of contaminants measured at the Brick-lined pits are also indicated in Table 2. None of the maxima exceed the S-1/GW-1 standards or the RCS1 criteria.

Table 2. Comparison of Brick-lined pit soil results with MCP criteria.

Analyte	MCP RCS1 Soil Reportable Conc. (mg/kg)	MCP S-1/GW-1 Soil Standard (mg/kg)	Maximum Level at Brick-lined Pits (mg/kg)
Acetone	3	3	0.014
BEHP	100	100	2.6
Calcium	NA	-	362
Copper	1000	-	8.0
Lead	300	300	53.6
Magnesium	NA	-	1680
Manganese	-	-	914
Molybdenum	-	-	0.71
Nitrate/Nitrite	-	-	0.06
Nitrogen, ammonia	-	-	8.95
Thallium	8	8	1.5

NA = MCP-listed analyte with no applicable standard
- = Analyte not listed under the referenced MCP table

6. Conclusions

The data indicate that no explosive compounds are present in either brick-lined pit. The contaminants present in these pits appear to consist of metals, with little apparent migration of the compounds into the surrounding soil. The measured concentrations do not exceed cleanup or reporting criteria established for the Commonwealth of Massachusetts. No site-specific cleanup criteria have been established for soils.

7. Recommendations

No further investigation of the brick-lined pits is recommended based on the types of debris identified in the brick-lined pits and the results of the soil analyses. However, as indicated in Section 2.3, these locations are part of the J-2 Range which remains to be investigated under the IAGS. If deemed necessary, additional sampling in and around the Brick Lined Pits can be conducted as part of that investigation. Sampling details including sample types, locations, and analytical parameters will be developed in consultation with EPA and MA DEP, and will be in accordance with the Final Propellants, Explosives, and Pyrotechnics (PEP) Analytical Report as necessary.

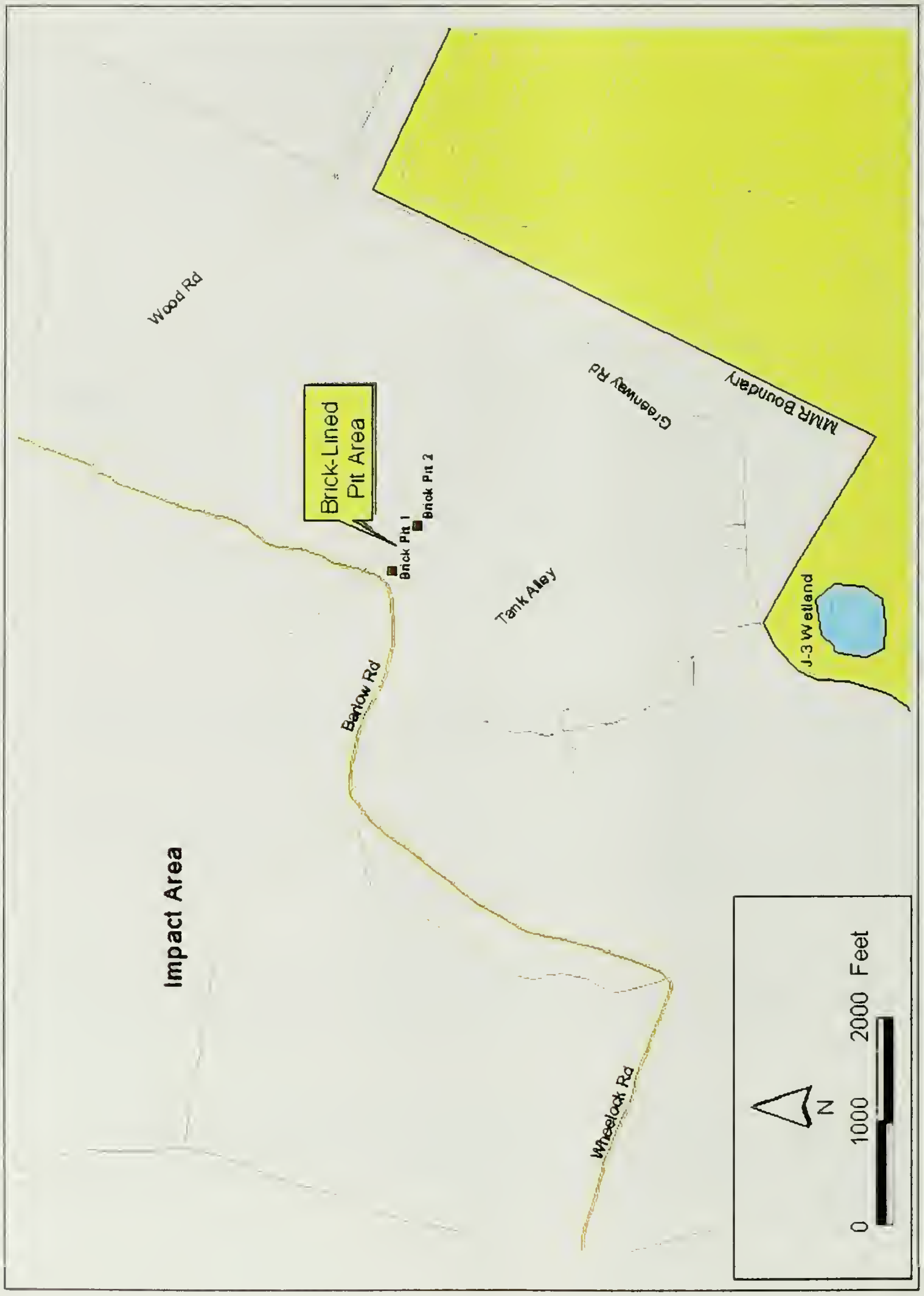
8. References

ASTM. 1996. Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities. Version 7:3r.034.01.014

Engineering Technologies Associates (ETA). 1997. Final Action Plan for the Camp Edwards Impact Area Groundwater Quality Study. July 1997. Engineering Technologies Associates, Inc. Ellicott City, Maryland.

Ogden. 1998a. Draft Completion of Work Report for the Camp Edwards Impact Area Groundwater Quality Study Massachusetts Military Reservation Cape Cod, Massachusetts. July, 1998. Ogden Environmental and Energy Services. Westford, MA.

USACE. 1999. Ordnance and Explosives Archives Search Report: Findings, Conclusions, and Recommendations for the Massachusetts Military Reservation Falmouth, Massachusetts, March 1999. U. S. Army Corps of Engineers, Rock Island District. Rock Island, IL.



Location of Brick Pits at MMR

Figure 1

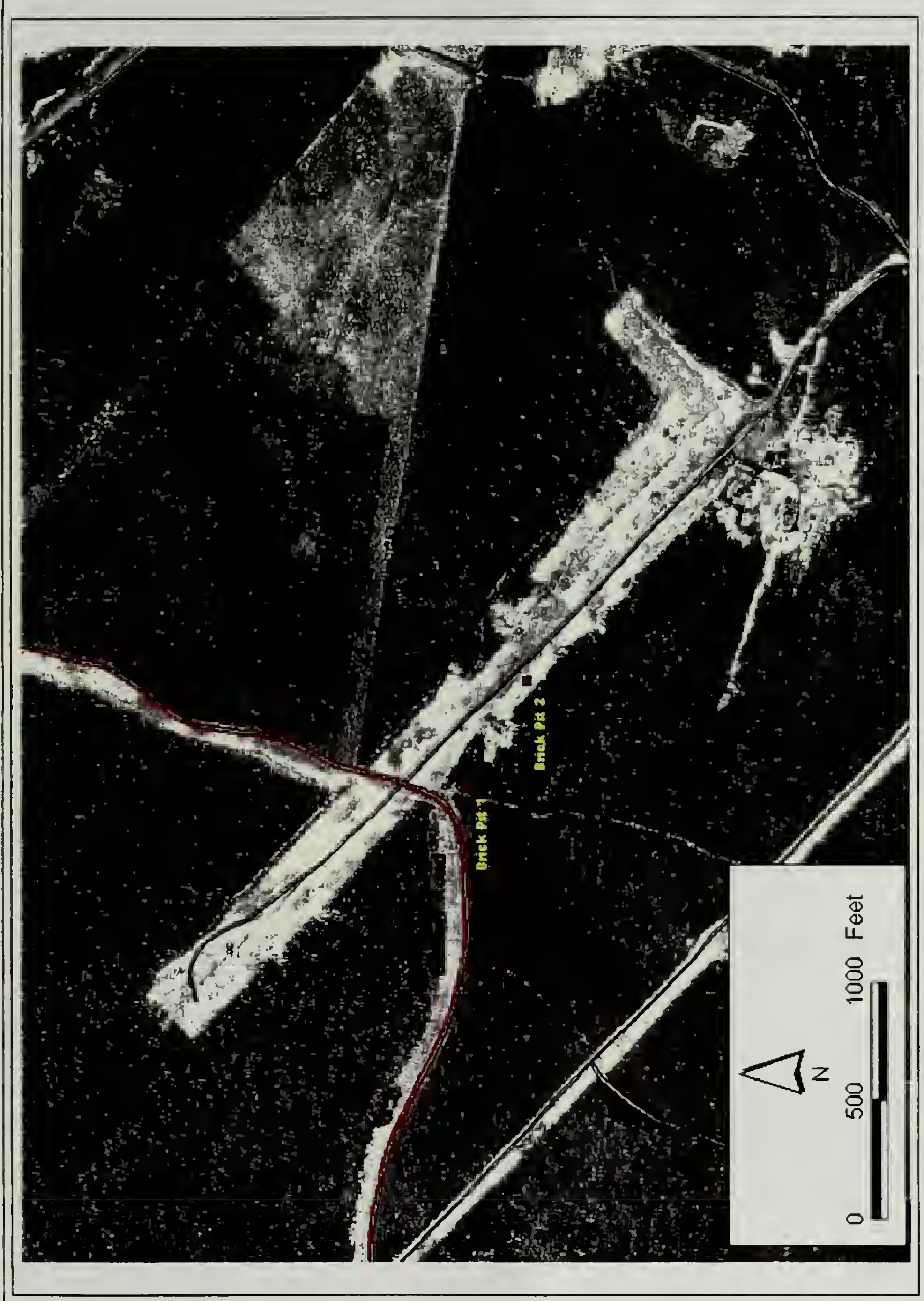


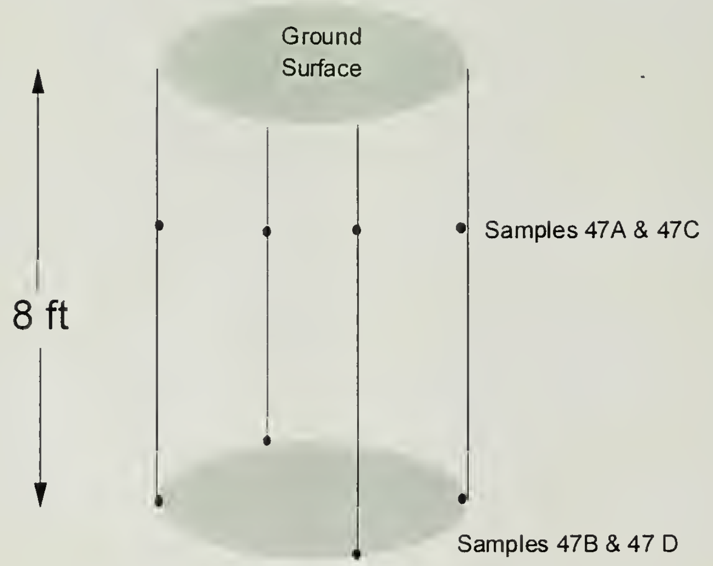
Figure 2

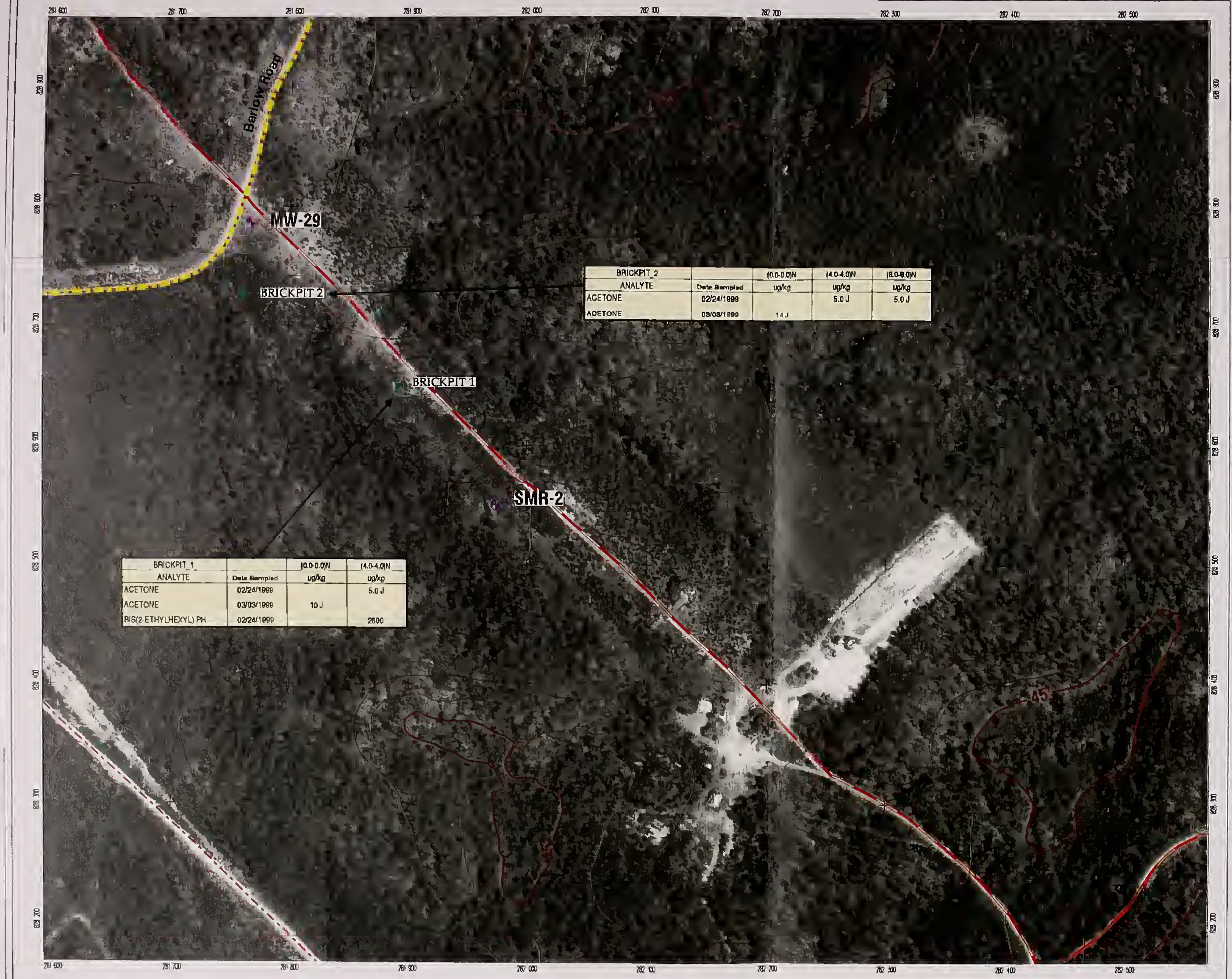
Historic Extent of J-2 Range circa 1966

Historic 1:2000 Scale Aerial Photo
Flown February 1966

L:\MMR\GIS\Study\Historic Location of Brick Pits
July 27, 1999

Figure 3. Location of sample composite points from within the brick-lined pits.





BRICKPIT_2		(0.0-0.0)N	(4.0-4.0)N	(8.0-8.0)N
ANALYTE	Date Sampled	ug/kg	ug/kg	ug/kg
ACETONE	02/24/1999		5.0 J	5.0 J
ACETONE	03/03/1999	14 J		

BRICKPIT_1		(0.0-0.0)N	(4.0-4.0)N
ANALYTE	Date Sampled	ug/kg	ug/kg
ACETONE	02/24/1999		5.0 J
ACETONE	03/03/1999	10 J	
BIS(2-ETHYLHEXYL) PH	02/24/1999		2600

MMR Groundwater Study

LEGEND

●	Groundwater Wells
▨	Soil Sample Grids

ug/kg	Micrograms Per Kilogram
J	Estimated Quantity

IMAGE DATE: 1994
All sample depth measurements are in feet

BASEMAP LEGEND

🟨	Impact Area Boundary
▨	Water Bodies
🟥	Roads
▨	Paths
▨	Power/Transmission Lines
▨	3 Meter Contours

LOCATION MAP

NOTES & SOURCES

Map coordinates: Stateplane, NAD83, Zone 4151, Meters

ORTHOPHOTOGRAPHY: 1:5000 digital black & white orthophotos
Source: MASSGIS; Resolution: 1/2 meter; Date Flown: 1994

TOPOGRAPHY: 3 meter contours generated from digital terrain models (DTMs)
Source: MASSGIS

TITLE

CONCENTRATIONS OF
ALL CHEMICALS (EXCEPT METALS)
IN BRICK PIT SOIL SAMPLES
Area 47

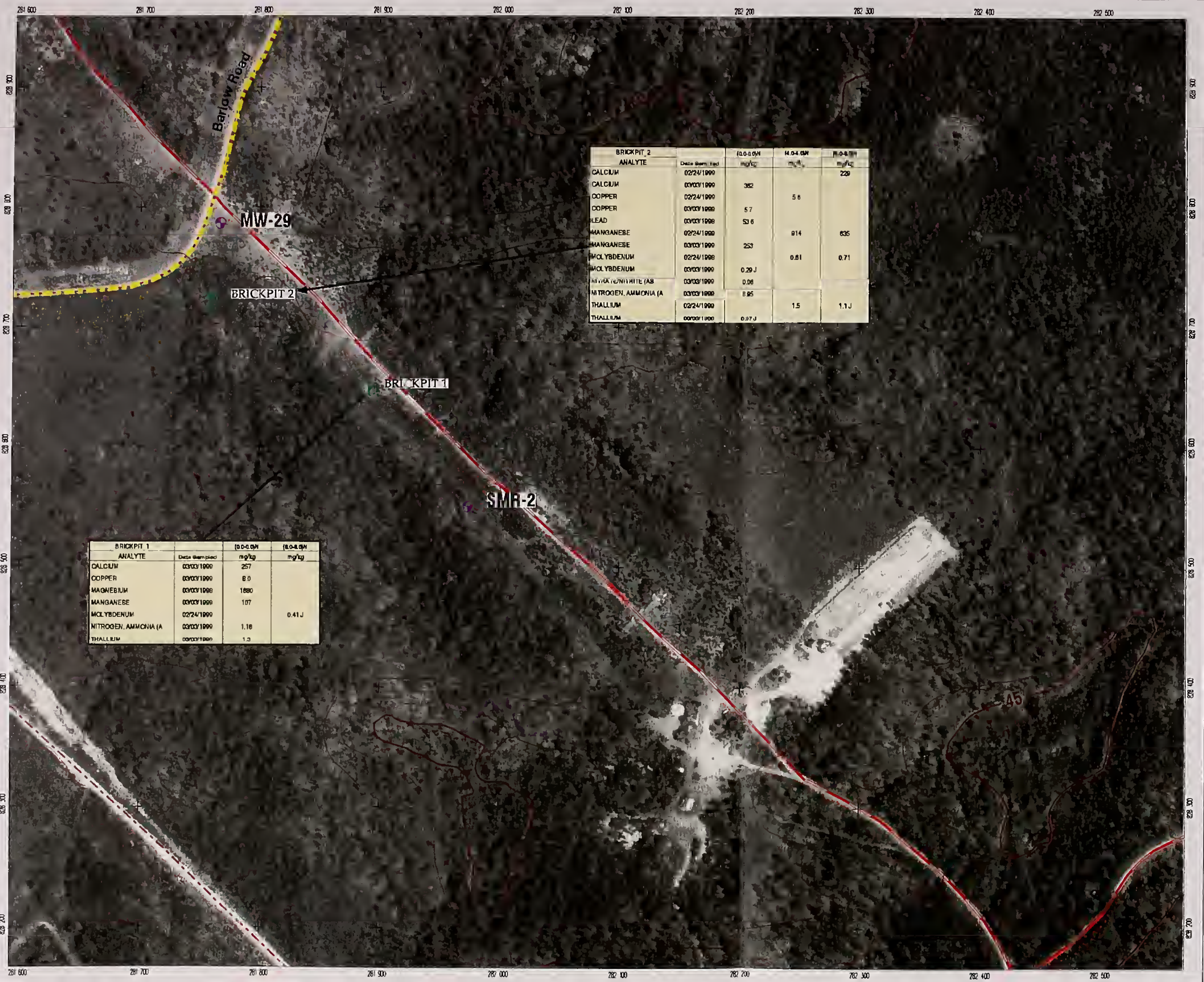
N

0 275
FEET
0 84
METERS

DATE	REV.	DRWN.	INIT.	CHKD.	INIT.	APPR.	INIT.
08/03/99							

FIGURE
4

/oahu/mmrdata/mmr/spatial/ogden/amls/qd_mmr.aml map MMR4799



BRICKPIT_2 ANALYTE	Date Sampled	(0.0-0.0)ft mg/kg	(4.0-4.0)ft mg/kg	(8.0-8.0)ft mg/kg
CALCIUM	02/24/1999			229
CALCIUM	03/03/1999	362		
COPPER	02/24/1999		5.6	
COPPER	03/03/1999	5.7		
LEAD	03/03/1999	53.6		
MANGANESE	02/24/1999		814	635
MANGANESE	03/03/1999	253		
MOLYBDENUM	02/24/1999		0.81	0.71
MOLYBDENUM	03/03/1999	0.29 J		
NITRATE/NITRITE (AS	03/03/1999	0.06		
NITROGEN, AMMONIA (A	03/03/1999	8.95		
THALLIUM	02/24/1999		1.5	1.1 J
THALLIUM	03/03/1999	0.97 J		

BRICKPIT_1 ANALYTE	Date Sampled	(0.0-0.0)ft mg/kg	(8.0-8.0)ft mg/kg
CALCIUM	03/03/1999	257	
COPPER	03/03/1999	8.0	
MAGNESIUM	03/03/1999	1690	
MANGANESE	03/03/1999	107	
MOLYBDENUM	02/24/1999		0.41 J
NITROGEN, AMMONIA (A	03/03/1999	1.18	
THALLIUM	03/03/1999	1.3	

MMR Groundwater Study

LEGEND

●	Groundwater Wells
▨	Soil Sample Grids

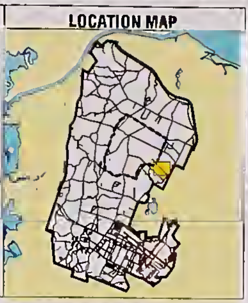
mg/kg	Milligrams Per Kilogram
J	Estimated Quantity

IMAGE DATE: 1994
All sample depth measurements are in feet

BASEMAP LEGEND

🟨	Impact Area Boundary
▨	Water Bodies
🟥	Roads
▨	Paths
▨	Power/Transmission Lines
▨	3 Meter Contours

LOCATION MAP



NOTES & SOURCES

Map coordinates: Stateplane, NAD83, Zone 4151, Meters

ORTHOPHOTOGRAPHY: 1:5000 digital black & white orthophotos
Source: MASSGIS; Resolution: 1/2 meter; Date Flown: 1994

TOPOGRAPHY: 3 meter contours generated from digital terrain models (DTMs)
Source: MASSGIS

TITLE

CONCENTRATIONS OF METALS/INORGANICS IN BRICK PIT SOIL SAMPLES
Area 47

N

0 275
FEET

0 84
METERS

DATE	REV.	DRWN.	INIT.	CHKD.	INIT.	APPR.	INIT.
08/03/99							

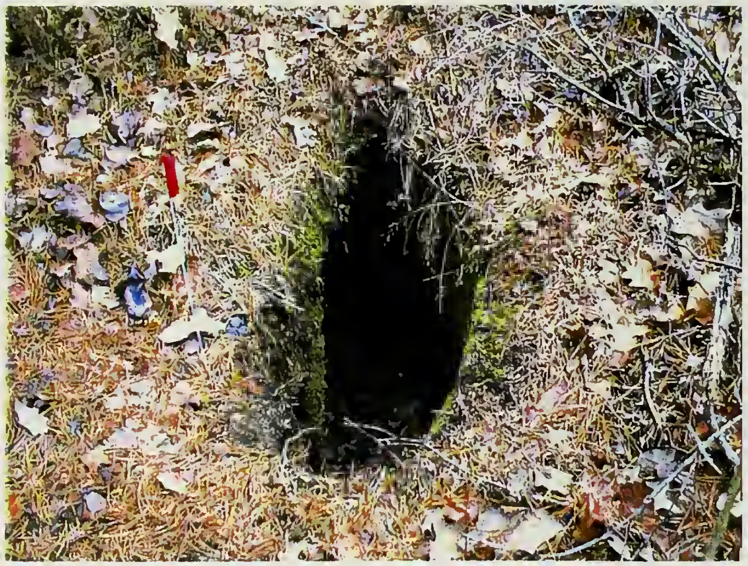
FIGURE
5

/oahu/mmrdata/mmr/spatial/ogden/amls/qd_mmr.aml map MMR472

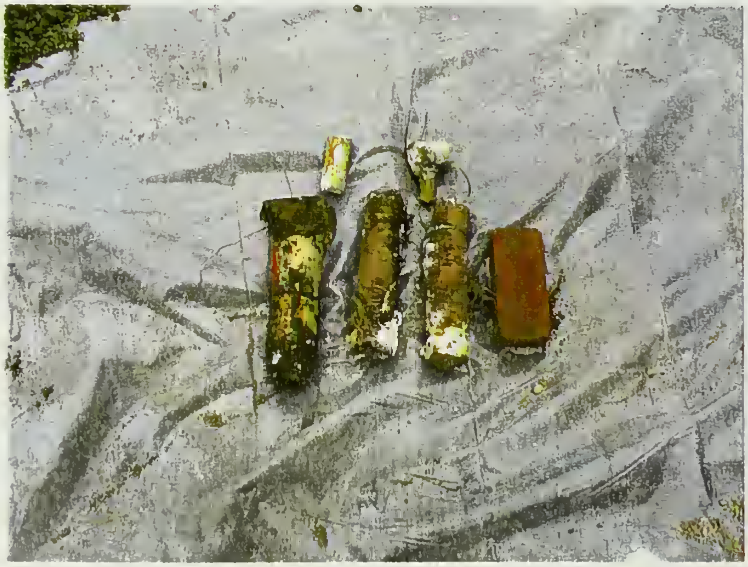
Photograph A. Brick-lined pit #1.

Photograph B. Material removed from Brick-lined pit #1.

Photograph C. Brick-lined pit #2.



Photograph D. Material removed from Brick-lined pit #2.



Appendix A. Summary of Sampling Results – Brick Lined Pit Soils

Sample ID	Sample Date	QC Val	Lab Method	Analyte	Value	Flag	Units	Depth Interval		Sample Type
B47AAA	24-Feb-99	II	350.2M	{ND on all 1} analytes				4	4	SOIL
		II	353.2M	{ND on all 1} analytes						
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	123		MG/KG			
		II	8021S	{ND on all 2} analytes						
		II	8151	{ND on all 18} analytes						
		II	8330N	{ND on all 19} analytes						
		II	9038	{ND on all 1} analytes						
		II	9250	CHLORIDE (AS CL)	0.9		MG/KG			
		II	CYAN	{ND on all 1} analytes						
		NV	D2216M	MOISTURE	4.5	*	PERCENT			
		II	IM40HG	{ND on all 1} analytes						
		II	IM40MB	ALUMINUM	2560		MG/KG			
		II	IM40MB	ARSENIC	1.5	J	MG/KG			
		II	IM40MB	BARIUM	5		MG/KG			
		II	IM40MB	BERYLLIUM	0.17		MG/KG			
		II	IM40MB	CALCIUM	187		MG/KG			
		II	IM40MB	CHROMIUM, TOTAL	3.3		MG/KG			
		II	IM40MB	COBALT	1.8		MG/KG			
		II	IM40MB	COPPER	3.8		MG/KG			
		II	IM40MB	IRON	4870		MG/KG			
		II	IM40MB	LEAD	3.5		MG/KG			
		II	IM40MB	MAGNESIUM	788		MG/KG			
		II	IM40MB	MANGANESE	94.3		MG/KG			
		II	IM40MB	NICKEL	2.7		MG/KG			
		II	IM40MB	POTASSIUM	260		MG/KG			
		II	IM40MB	VANADIUM	7.8		MG/KG			
		II	IM40MB	ZINC	13.8		MG/KG			
		II	OM31B	BIS(2-ETHYLHEXYL) PHTHALATE	2600		UG/KG			
		II	OM31P	{ND on all 28} analytes						
		II	OM31V	ACETONE	5	J	UG/KG			
		II	TOC	{ND on all 1} analytes						
B47BAA	24-Feb-99	II	350.2M	{ND on all 1} analytes				8	8	SOIL
		II	353.2M	NITRATE/NITRITE (AS N)	0.01		MG/KG			
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	97		MG/KG			
		II	8021S	{ND on all 2} analytes						
		II	8151	{ND on all 18} analytes						
		II	8330N	{ND on all 19} analytes						
		II	9038	SULFATE (AS SO4)	96		MG/KG			
		II	9250	CHLORIDE (AS CL)	3.8		MG/KG			
		II	CYAN	{ND on all 1} analytes						

Appendix A. Summary of Sampling Results – Brick Lined Pit Soils

Sample ID	Sample Date	QC Val	Lab Method	Analyte	Value	Flag	Units	Depth Interval	Sample Type
		NV	D2216M	MOISTURE	12.8	*	PERCENT		
		II	IM40HG	{ND on all 1} analytes					
		II	IM40MB	ALUMINUM	3860		MG/KG		
		II	IM40MB	ARSENIC	1.6	J	MG/KG		
		II	IM40MB	BARIUM	6.9		MG/KG		
		II	IM40MB	BERYLLIUM	0.19		MG/KG		
		II	IM40MB	CALCIUM	153		MG/KG		
		II	IM40MB	CHROMIUM, TOTAL	5.4		MG/KG		
		II	IM40MB	COBALT	2.5		MG/KG		
		II	IM40MB	COPPER	3.9		MG/KG		
		II	IM40MB	IRON	5100		MG/KG		
		II	IM40MB	LEAD	3.5		MG/KG		
		II	IM40MB	MAGNESIUM	815		MG/KG		
		II	IM40MB	MANGANESE	80.6		MG/KG		
		II	IM40MB	MOLYBDENUM	0.41	J	MG/KG		
		II	IM40MB	NICKEL	3.8		MG/KG		
		II	IM40MB	POTASSIUM	303		MG/KG		
		II	IM40MB	VANADIUM	8.1		MG/KG		
		II	IM40MB	ZINC	9.7		MG/KG		
		II	OM31B	{ND on all 64} analytes					
		II	OM31P	{ND on all 28} analytes					
		II	OM31V	{ND on all 33} analytes					
		II	TOC	TOTAL ORGANIC CARBON	350		MG/KG		
B47CAA	24-Feb-99	II	350.2M	{ND on all 1} analytes				4 4	SOIL
		II	353.2M	NITRATE/NITRITE (AS N)	0.02		MG/KG		
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	135		MG/KG		
		II	8021S	{ND on all 2} analytes					
		II	8151	{ND on all 18} analytes					
		II	8330N	{ND on all 19} analytes					
		II	9038	{ND on all 1} analytes					
		II	9250	CHLORIDE (AS CL)	1.6		MG/KG		
		II	CYAN	{ND on all 1} analytes					
		NV	D2216M	MOISTURE	4.5	*	PERCENT		
		II	IM40HG	{ND on all 1} analytes					
		II	IM40MB	ALUMINUM	2180		MG/KG		
		II	IM40MB	ARSENIC	1.3	J	MG/KG		
		II	IM40MB	BARIUM	21.5		MG/KG		
		II	IM40MB	CALCIUM	103		MG/KG		
		II	IM40MB	CHROMIUM, TOTAL	3.3		MG/KG		
		II	IM40MB	COBALT	3		MG/KG		

Appendix A. Summary of Sampling Results – Brick Lined Pit Soils

Sample ID	Sample Date	QC Val	Lab Method	Analyte	Value	Flag	Units	Depth Interval	Sample Type
		II	IM40MB	COPPER	5.6		MG/KG		
		II	IM40MB	IRON	3730		MG/KG		
		II	IM40MB	LEAD	3.8		MG/KG		
		II	IM40MB	MAGNESIUM	501		MG/KG		
		II	IM40MB	MANGANESE	914		MG/KG		
		II	IM40MB	MOLYBDENUM	0.61		MG/KG		
		II	IM40MB	NICKEL	3		MG/KG		
		II	IM40MB	POTASSIUM	284		MG/KG		
		II	IM40MB	THALLIUM	1.5		MG/KG		
		II	IM40MB	VANADIUM	5.9		MG/KG		
		II	IM40MB	ZINC	17.6		MG/KG		
		II	OM31B	{ND on all 64} analytes					
		II	OM31P	{ND on all 28} analytes					
		II	OM31V	ACETONE	5	J	UG/KG		
		II	TOC	TOTAL ORGANIC CARBON	220		MG/KG		
B47DAA	24-Feb-99	II	350.2M	{ND on all 1} analytes				8 8	SOIL
		II	353.2M	NITRATE/NITRITE (AS N)	0.03		MG/KG		
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	134		MG/KG		
		II	8021S	{ND on all 2} analytes					
		II	8151	{ND on all 18} analytes					
		II	8330N	{ND on all 19} analytes					
		II	9038	SULFATE (AS SO4)	6		MG/KG		
		II	9250	CHLORIDE (AS CL)	1.4		MG/KG		
		II	CYAN	{ND on all 1} analytes					
		NV	D2216M	MOISTURE	7.1	*	PERCENT		
		II	IM40HG	{ND on all 1} analytes					
		II	IM40MB	ALUMINUM	3210		MG/KG		
		II	IM40MB	ARSENIC	1.3	J	MG/KG		
		II	IM40MB	BARIUM	15.8		MG/KG		
		II	IM40MB	CALCIUM	229		MG/KG		
		II	IM40MB	CHROMIUM, TOTAL	4.5		MG/KG		
		II	IM40MB	COBALT	2.7		MG/KG		
		II	IM40MB	COPPER	4.7		MG/KG		
		II	IM40MB	IRON	4610		MG/KG		
		II	IM40MB	LEAD	3.8		MG/KG		
		II	IM40MB	MAGNESIUM	719		MG/KG		
		II	IM40MB	MANGANESE	635		MG/KG		
		II	IM40MB	MOLYBDENUM	0.71		MG/KG		
		II	IM40MB	NICKEL	3.4		MG/KG		
		II	IM40MB	POTASSIUM	244		MG/KG		

Appendix A. Summary of Sampling Results – Brick Lined Pit Soils

Sample ID	Sample Date	QC Val	Lab Method	Analyte	Value	Flag	Units	Depth Interval	Sample Type
		II	IM40MB	THALLIUM	1.1	J	MG/KG		
		II	IM40MB	VANADIUM	7		MG/KG		
		II	IM40MB	ZINC	12.2		MG/KG		
		II	OM31B	{ND on all 64} analytes					
		II	OM31P	{ND on all 28} analytes					
		II	OM31V	ACETONE	5	J	UG/KG		
		II	TOC	TOTAL ORGANIC CARBON	631		MG/KG		
B47EAA	3-Mar-99	II	350.2M	NITROGEN, AMMONIA (AS N)	1.18		MG/KG	0 0	SOIL
		II	353.2M	NITRATE/NITRITE (AS N)	0.03		MG/KG		
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	63.4	J	MG/KG		
		II	8021S	{ND on all 2} analytes					
		II	8151	{ND on all 18} analytes					
		II	8330N	{ND on all 19} analytes					
		II	9038	SULFATE (AS SO4)	13.2		MG/KG		
		II	9250	CHLORIDE (AS CL)	0.8		MG/KG		
		II	CYAN	{ND on all 1} analytes					
		NV	D2216M	MOISTURE	9.3	*	PERCENT		
		II	IM40HG	{ND on all 1} analytes					
		II	IM40MB	ALUMINUM	6230		MG/KG		
		II	IM40MB	BARIUM	8.9		MG/KG		
		II	IM40MB	BERYLLIUM	0.25		MG/KG		
		II	IM40MB	CALCIUM	257		MG/KG		
		II	IM40MB	CHROMIUM, TOTAL	9.8		MG/KG		
		II	IM40MB	COBALT	4.1		MG/KG		
		II	IM40MB	COPPER	8		MG/KG		
		II	IM40MB	IRON	8200		MG/KG		
		II	IM40MB	LEAD	9.2		MG/KG		
		II	IM40MB	MAGNESIUM	1680		MG/KG		
		II	IM40MB	MANGANESE	107		MG/KG		
		II	IM40MB	NICKEL	5.9		MG/KG		
		II	IM40MB	POTASSIUM	319		MG/KG		
		II	IM40MB	THALLIUM	1.3		MG/KG		
		II	IM40MB	VANADIUM	11.8		MG/KG		
		II	IM40MB	ZINC	19.8		MG/KG		
		II	OM31B	{ND on all 64} analytes					
		II	OM31P	{ND on all 28} analytes					
		II	OM31V	ACETONE	10	J	UG/KG		
		II	TOC	TOTAL ORGANIC CARBON	1030		MG/KG		
B47FAA	3-Mar-99	II	350.2M	NITROGEN, AMMONIA (AS N)	8.95		MG/KG	0 0	SOIL

Appendix A. Summary of Sampling Results – Brick Lined Pit Soils

Sample ID	Sample Date	QC Val	Lab Method	Analyte	Value	Flag	Units	Depth Interval	Sample Type
		II	353.2M	NITRATE/NITRITE (AS N)	0.06		MG/KG		
		II	365.2	PHOSPHORUS, TOTAL ORTHOPHOSPHATE	89.9	J	MG/KG		
		II	8021S	{ND on all 2} analytes					
		II	8151	{ND on all 18} analytes					
		II	8330N	{ND on all 19} analytes					
		II	9038	SULFATE (AS SO4)	13.5		MG/KG		
		II	9250	CHLORIDE (AS CL)	1		MG/KG		
		II	CYAN	{ND on all 1} analytes					
		NV	D2216M	MOISTURE	18.7	*	PERCENT		
		II	IM40HG	{ND on all 1} analytes					
		II	IM40MB	ALUMINUM	8180		MG/KG		
		II	IM40MB	BARIUM	15.7		MG/KG		
		II	IM40MB	BERYLLIUM	0.26		MG/KG		
		II	IM40MB	CALCIUM	362		MG/KG		
		II	IM40MB	CHROMIUM, TOTAL	9.9		MG/KG		
		II	IM40MB	COBALT	3.4		MG/KG		
		II	IM40MB	COPPER	5.7		MG/KG		
		II	IM40MB	IRON	10000		MG/KG		
		II	IM40MB	LEAD	53.6		MG/KG		
		II	IM40MB	MAGNESIUM	1210		MG/KG		
		II	IM40MB	MANGANESE	253		MG/KG		
		II	IM40MB	MOLYBDENUM	0.29	J	MG/KG		
		II	IM40MB	NICKEL	5.1		MG/KG		
		II	IM40MB	POTASSIUM	382		MG/KG		
		II	IM40MB	THALLIUM	0.97	J	MG/KG		
		II	IM40MB	VANADIUM	15.3		MG/KG		
		II	IM40MB	ZINC	17.9		MG/KG		
		II	OM31B	{ND on all 64} analytes					
		II	OM31P	{ND on all 28} analytes					
		II	OM31V	ACETONE	14	J	UG/KG		
		II	TOC	TOTAL ORGANIC CARBON	3710		MG/KG		
		II	8151	{ND on all 18} analytes					
		II	OM31V	{ND on all 33} analytes					

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